# TDA7338

## STEREO DECODER

## 1 FEATURES

- INTEGRATED 19KHz SC NOTCH FILTERFOR PILOT CANCELLATION
- ON CHIP FILTER FOR PILOT DETECTOR AND PLL
- ADJUSTMENT FREE VOLTAGE CONTROLLED OSCILLATOR
- AUTOMATIC PILOT DEPENDENT MONO/ STEREO SWITCHING
- NOISE BLANKING WITH PROGRAMMABLE THRESHOLD
- HIGH CUT CONTROL AND STEREO BLEND INTEGRATED HIGH PASS FILTER FOR INTERFERENCE DETECTOR
- LEVEL INPUT FOR ADDITIONAL SPIKE DETECTION ON FIELDSTRENGHT SIGNAL
- VERY HIGH SUPPRESSION OF HARMON'C AND INTERFERENCE SIGNALS
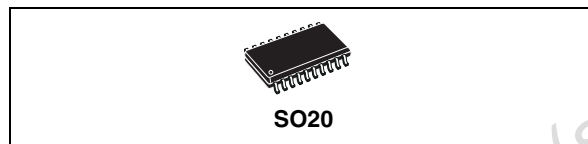
**Figure 1. Package**



**SO20**

**Table 1. Order Codes**

| Part Number | Package |
|---|---|
| TDA7338D | SO20 |
| TDA7338D013TR | SO20 in Tape & Reel |

## 2 DESCRIPTION

The TDA7338 is a new concept of monolithic integrated stereo decoder with noise blanking for FM car radio applications. With the used BICMOS technique, the 19KHz Notch Filter, the PLL Filter and Phase Filter is realized on the chip with a Switched Capacitor concept. Avoiding the use of multipliers and non linear circuits a very high performance in terms of noise suppression and total harmonic distortion is
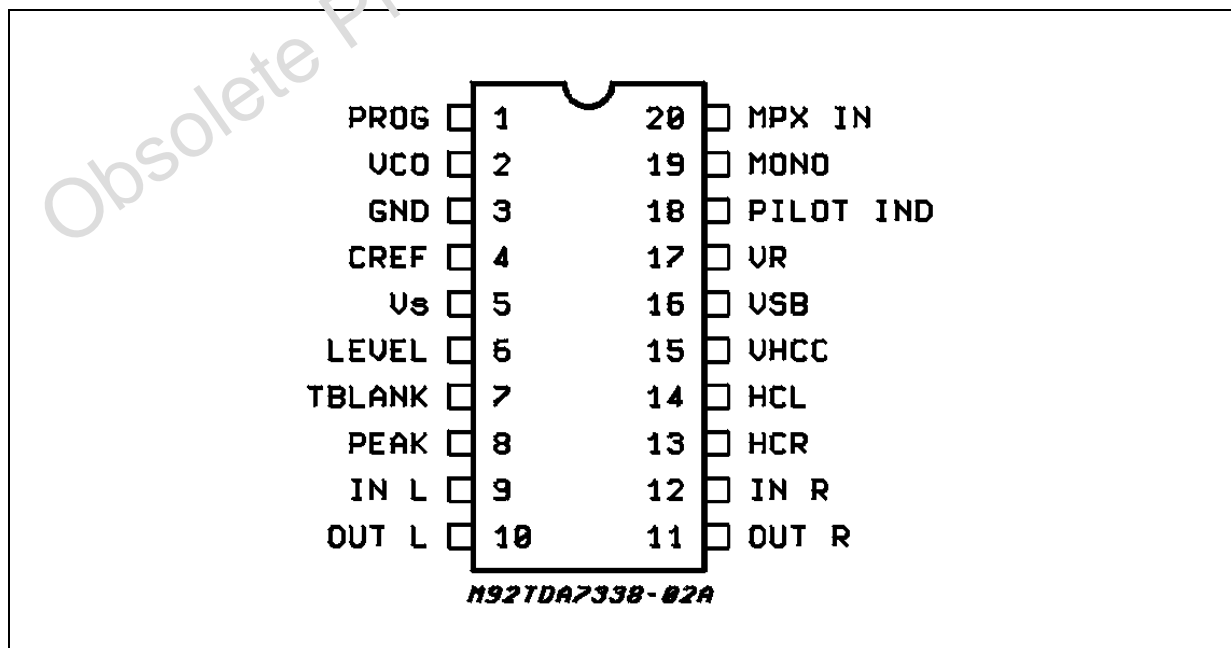
**Figure 2. reached.Block Diagram**



```
        PROG ☐  1      20 ☐ MPX IN
        VCO  ☐  2      19 ☐ MONO
        GND  ☐  3      18 ☐ PILOT IND
        CREF ☐  4      17 ☐ VR
        Vs   ☐  5      16 ☐ VSB
       LEVEL ☐  6      15 ☐ VHCC
      TBLANK ☐  7      14 ☐ HCL
        PEAK ☐  8      13 ☐ HCR
        IN L ☐  9      12 ☐ IN R
       OUT L ☐ 10      11 ☐ OUT R
```

M92TDA7338-02A

## Table 2. Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit |
|--------|-----------|-------|------|
| $V_{CC}$ | DC Supply Voltage | 10.5 | V |
| $I_{CC}$ | Suply Current | 20 | mA |
| $T_{stg}$ | Storage Temperature | -55 to 150 | °C |
| $T_{amb}$ | Operating AmbientTemperature | -40 to 85 | °C |

## Table 3. Thermal Data

| Symbol | Parameter | Value | Unit |
|--------|-----------|-------|------|
| $R_{th\ j\text{-}pins}$ | Thermal resistance junction-pins | 200 | °C/W |

## Figure 3. Block Diagram and Test Circuit
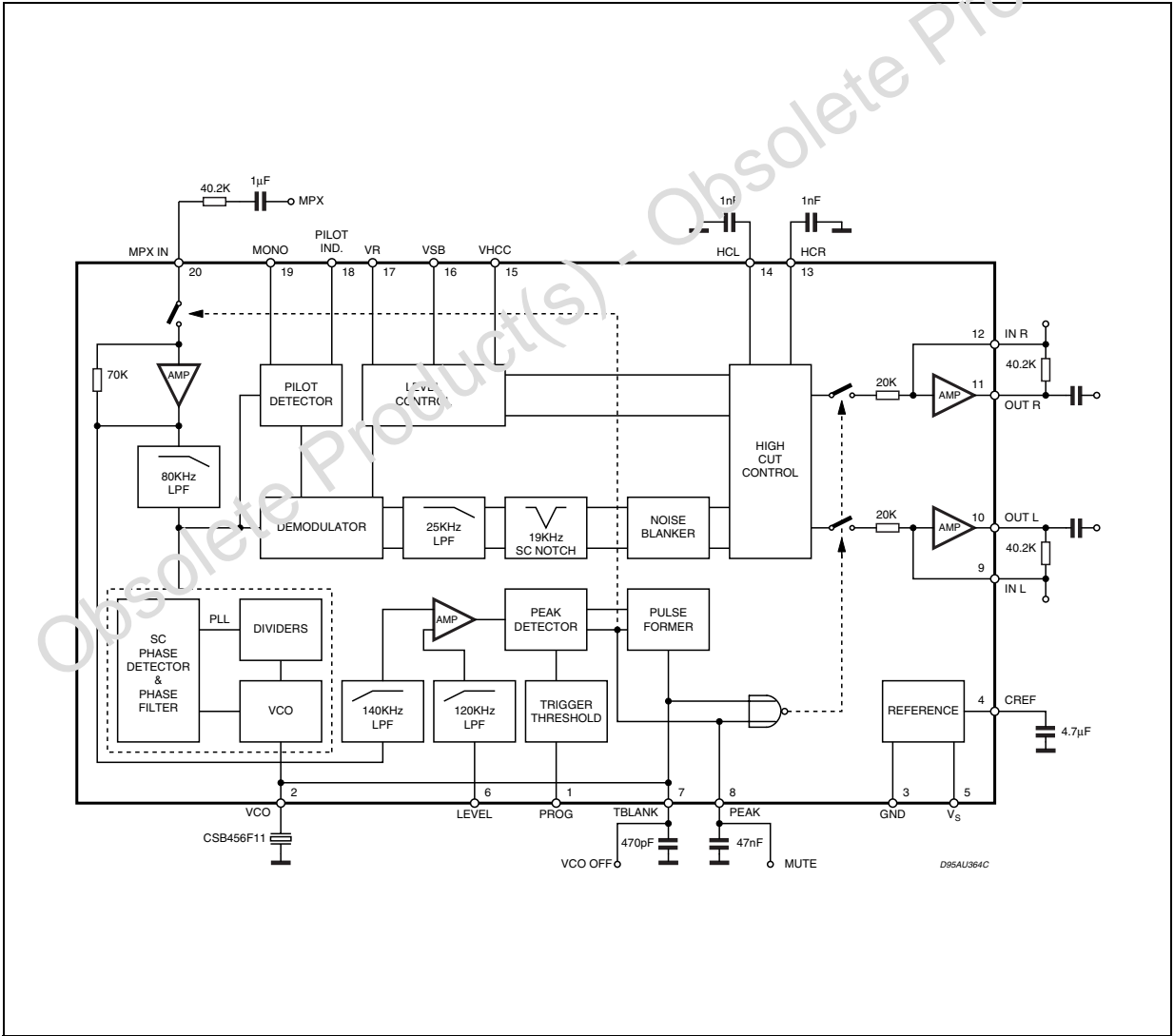
# 3 ELECTRICAL CHARACTERISTCS

**Table 4.**

($V_{CC}$ = 9V; modulation frequency: 1KHz; de-emphasis time: T = 50µs; nominal MPX input voltage:
$V_{MPX}$ = 1.5$V_{PP}$; m 100% (75KHz deviation, $f_{mod}$ = 1KHz); $R_{IN}$ = 40.2kΩ, $R_{OUT}$ = 40.2kΩ;
$T_{amb}$ = 27°C; $C_{REF}$ = 4.7µF; unless otherwise specified)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | 7.5 | 9 | 10.2 | V |
| $I_{CC}$ | Supply Current | | 5 | 10 | 15 | mA |
| $V_{IN}$ | MPX Input Level (peak to peak) | $f_m$ = 1KHz | | 1.5 | | V |
| $V_{ORMS}$ | A.F. Output Voltage (mono) | pin 10 and 11 $V_{IN}$ = 0.5$V_{RMS}$ MONO; | | 1.5 | | V |
| SVRR | Supply Voltage Ripple Rejection | $V_{RIPPLE}$ = 200mV; f = 1KHz | 40 | 55 | | dB |
| $V_L/V_R$ | Difference of Output Voltage Levels | pin 10 and 11- mono | -0.8 | | 0.8 | dB |
| $V_o/V_i$ | Gain | $V_{10}/V_{20}$ | 8.5 | 9.5 | 10.5 | dB |
| $R_O$ | Output Resistance | pin 10 and 11 | | 10 | 50 | Ω |
| $V_O$ | DC Output Voltage | pin 10 and 11 | 4.2 | 4.5 | 4.8 | V |
| α | Channel Separation | $V_R$ - $V_{SB}$ = -50m$V_{DC}$ | 30 | 45 | | dB |
| THD | Total Harmonic Distortion | | | 0.02 | 0.3 | % |
| $\dfrac{S + N}{N}$ | Signal plus noise to noise ratio | f = 20Hz to 16KHz; S = 2Vrms | | 91 | | dB |
| $α_M$ | Muting Attenuation | $V_7$ and $V_8$ < 0.6V | | 100 | | dB |
| $V_{DC}$ | Mute DC Steps at pins 10, 11 | Mute at pin 8 | | 0 | 4 | mV |
| **CARRIER AND HARMONIC SUPPRESSION AT THE OUTPUT** | | | | | | |
| α19 | Pilot Signal f = 19KHz | | 55 | 70 | | dB |
| α38 | Subcarrier f = 38KHz | | | 75 | | dB |
| α57 | Subcarrier f = 57KHz | | | 62 | | dB |
| α76 | Subcarrier f = 76KHz | | | 90 | | dB |
| **INTERMODULATION** (note 1) | | | | | | |
| α2 | $f_{mod}$ = 10KHz; $f_{spur}$ = 1KHz | | | 65 | | dB |
| α3 | $f_{mod}$ = 13KHz; $f_{spur}$ = 1KHz | | | 75 | | dB |
| **TRAFFIC RADIO** (note 2) | | | | | | |
| α57 | Signal f = 57KHz | | | 70 | | dB |
| **SCA - SUBSIDIARY COMMUNICATIONS AUTHORIZATION** (note 3) | | | | | | |
| α67 | Signal f = 67KHz | | | 75 | | dB |
| **ACI - ADJACENT CHANNEL INTERFERENCE** (note4) | | | | | | |
| α114 | Signal f = 114KHz | | | 95 | | dB |
| α190 | Signal f = 190KHz | | | 84 | | dB |
| **MONO/ STEREO SWITCH** | | | | | | |
| $V_{INTH}$ | Pilot Threshold Voltage | for stereo "ON" | 12 | 20 | 28 | m$V_{RMS}$ |
| $V_{INTH}$ | Pilot Threshold Voltage | for stereo "OFF" | 7 | 14 | 21 | m$V_{RMS}$ |
| $V_{PI}$ | Pilot Indicator Saturation Voltage | I = 1mA | | 0.2 | 0.5 | V |
| $I_{PI}$ | Pilot Indicator Leakage Current | V = 9V | | | 10 | µA |
| $V_{19}$ | Control Voltage for forced mono | α = < 3dB | | | 0.8 | V |

**Table 4.**

($V_{CC}$ = 9V; modulation frequency: 1KHz; de-emphasis time: T = 50$\mu$s; nominal MPX input voltage: $V_{MPX}$ = 1.5$V_{PP}$; m 100% (75KHz deviation, $f_{mod}$ = 1KHz); $R_{IN}$ = 40.2k$\Omega$, $R_{OUT}$ = 40.2k$\Omega$; $T_{amb}$ = 27°C; $C_{REF}$ = 4.7$\mu$F; unless otherwise specified)

| STEREO BLEND | | | | | | |
|---|---|---|---|---|---|---|
| $V_{16\text{-}17}$ | Control Voltage for Channel Separation | $\alpha$ = 6dB; $V_R$ = 3.6V (note 5) | -0.31 | -0.27 | -0.23 | V |
| $V_{16\text{-}17}$ | Control Voltage for Channel Separation | $\alpha$ = 26dB; | -85 | -55 | -30 | mV |
| **HIGH CUT CONTROL** | | | | | | |
| $\tau_{deemp}$ | De-Emphasis Time Constant | $C_{13}$, $C_{14}$ = 1nF; $V_{15\text{-}17}$ = 50mV | 43 | 50 | 57 | $\mu$s |
| $R_{15\text{-}17}$ | High Cut Control Resistance | $V_{15\text{-}17}$ = 50mV | 43 | 50 | 57 | K$\Omega$ |
| $R_{15\text{-}17}$ | High Cut Control Resistance | $V_{15\text{-}17}$ = -0.5V (note 5) | 115 | 150 | 185 | K$\Omega$ |
| **VCO** | | | | | | |
| $f_{osc}$ | Oscillator Frequency | with Murata CSB456F11 | | 456 | | KHz |
| $\Delta$f/f | Capture and Holding Range | | | +1 | | % |
| $V_{VCO}$ | $V_{CO\ OFF}$ | Pin 7 | | | 0.6 | V |
| **NOISE INTERFACE DETECTOR** (test condition: $V_{SB} > V_R$ + 50mV) | | | | | | |
| $V_{TR}$ | Trigger Threshold (note 6) | $V_{PEAK}$ = 1.3V; PROG = GND | | 180 | | mV |
| | | $V_{PEAK}$ = 1.3V; PROG = OPEN/$V_{DD}$ | | 250 | | mV |
| $V_{TR}$ | Trigger Threshold | $V_{PEAK}$ = 1.5V; PROG = GND | | 260 | | mV |
| | | $V_{PEAK}$ = 1.5V; PROG = OPEN/$V_{DD}$ | | 340 | | mV |
| $T_S$ | Suppression Pulse Duration | $C_{BLANK}$ = 470pF | | 50 | | $\mu$s |
| $I_{OS}$ | Input Offset Current during suppression time | | | 10 | | pA |
| $V_{N1}$ | $V_{PEAK}$ (pin 8) | $V_{IN}$ = 0m$V_{RMS}$ | 0.7 | 1.0 | 1.3 | V |
| $V_{N2}$ | $V_{PEAK}$ (pin 8) | $V_{IN}$ = 50m$V_{RMS}$; f = 150KHz | 1.1 | 1.5 | 2 | V |
| $V_{N3}$ | $V_{PEAK}$ (pin 8) | $V_{IN}$ = 100m$V_{RMS}$; f = 150KHz | 1.7 | 2.3 | 2.8 | V |

## 3.1 NOTES TO THE CHARACTERISTICS

1) INTERMODULATION SUPPRESSION

$$\alpha 2 = \frac{V_O(signal)(at 1KHz)}{V_O(spurious)(at 1KHz)} \quad ; f_s = (2 \times 10KHz) - 19KHz$$

$$\alpha 3 = \frac{V_O(signal)(at 1KHz)}{V_O(spurious)(at 1KHz)} \quad ; f_s = (3 \times 13KHz) - 38KHz$$

measured with : 91% mono signal; 9% pilot signal; fm=10KHz or 13KHz

2) TRAFFIC RADIO (V.F.) suppression

$$\alpha 57(V.W.F.) = \frac{V_O(signal)(at 1KHz)}{V_O(spurious)(at 1KHz \pm 23KHz)}$$

measured with : 91% stereo signal; 9% pilot signal; fm=1KHz; 5% subcarrier
(f = 57KHz, fm = 23Hz AM, m = 60%)

## 3. SCA (SUBSIDIARY COMMUNICATIONS AUTHORIZATION)

$$\alpha67 \ = \ \frac{V_O(signal)(at1KHz)}{V_O(spurious)(at9KHz)} \ ; f_s = (2 \times 38KHz) - 67KHz$$

measured with : 81% mono signal; 9% pilot signal; fm=1KHz;
          10% SCA - subcarrier (fs = 67KHz, unmodulated)

## 4. ACI (ADJACENT CHANNEL INTERFERENCE)

$$\alpha114 \ = \ \frac{V_O(signal)(at1KHz)}{V_O(spurious)(at4KHz)} \ ; f_s = 110KHz - (3 \times 38KHz)$$

$$\alpha190 \ = \ \frac{V_O(signal)(at1KHz)}{V_O(spurious)(at4KHz)} \ ; f_s = 186KHz - (5 \times 38KHz)$$

measured with : 90% mono signal; 9% pilot signal; fm=1KHz; 1% spurious signal
          (fs = 110KHz or 186KHz, unmodulated)

## 5. Control range typ 11% of VR (see figure 5 and figure 6)

## 6. MEASUREMENT OF TRIGGER THRESHOLDS

All thresholds are measured by using a pulse with $T_R$ = 2µs, $T_{HIGH}$ = 2µs, and $T_F$ = 10µs. The repetition rate must not increase the PEAK voltage.

**Figure 4.**
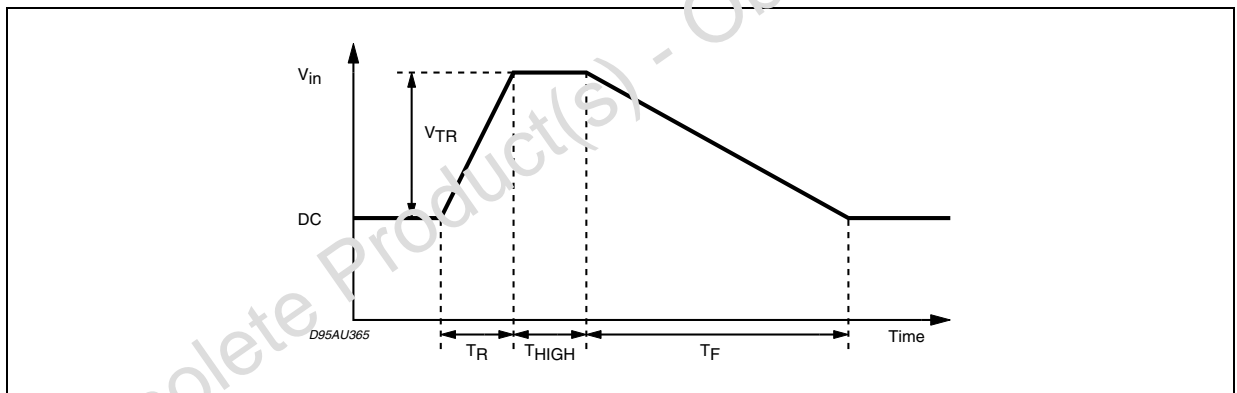


# 4  FUNCTIONAL DESCRIPTION

### 4.1  Signal Path

The TDA7338 Stereodecoder contains all necessary functions for processing the MPX signal. Due to the external input resistance (Pin 20) the circuit can be adapted to different MPX input levels. Behind a 80kHz lowpass filter the adjustment free PLL for the pilot Tone is placed.

The only external component needed for the PLL is the ceramic resonator for the oscillator which runs at 456kHz.

The pilot detector output is designed as an open collector output, therefore an external pullup resistor is needed. To force the decoder to "MONO" Pin 19 has to be clamped to a voltage below 0.8V.

The voltage level (signal strength from the IF part) applied to Pin 15 (VHCC) allows to control the time constant of the deemphasis (nom. = 50µs, see fig. 5). If the RF-signal is weak, the corner frequency is reduced down to 1kHz to improve the signal to noise ratio.

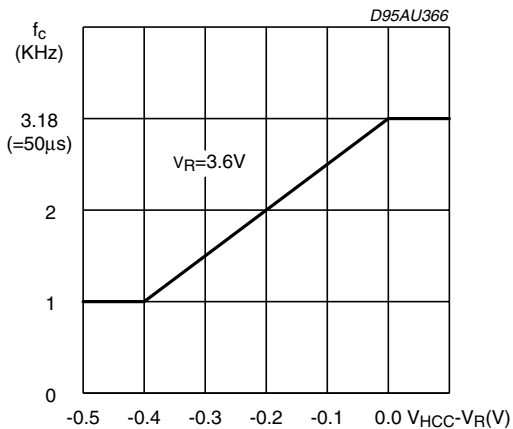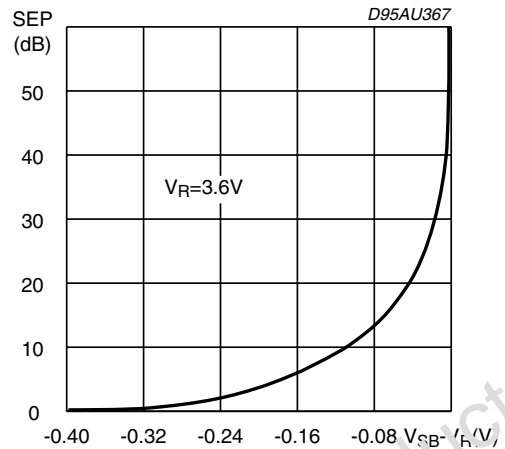**Figure 5. High Cut Control**



**Figure 6. Stereo Blend**



Furthermore the conditions of the stereo separation (see fig.6) can be controlled through the signal applied to Pin 16 (VSB). Both signal levels (VSB and VHCC) are referred to Pin 17 (VR), with the characteristic that the control range is 11% of VR. By modifying the feedback resistor value of the output stages (Pin 9 - 10, Pin 11 - 12) the total gain of the stereodecoder can be modified.

Pin 7 and Pin 8 have an additional function. By pulling them to ground the VCO-OFF (Pin 7) and the MUTE (Pin 8) function are activated. The MUTE signal disconnects the MPX signal from the circuit, while in combination with VCO-OFF also the output buffers are disconnected from the circuit. In this mode the output buffers can be used for AM-stereo, cassette play back and other purposes.

## 4.2 AM Mono Mode

By selecting VCO-OFF (Pin 7 to GND) the VCO is switched off and the SB and HCC are disabled. The deemphasis time constant is changed to 40µs (f$_c$ = 4KHz).

## 4.3 DESCRIPTION OF THE NOISE BLANKER

In the normal automotive environment the MPX signal is disturbed by ignition spikes, motors and high frequency switches etc.

The aim of the noise blanker part is to cancel the influence of the spikes produced by these components. Therefore the output of the stereodecoder is switched off for a time of 40µs (average spike duration).

In a first stage the spikes must be detected but to avoid a wrong triggering on high frequency noise a complex trigger control is implemented. Behind the trigger stage a pulse former generates the 40ms "blanking" pulse. This duration of 40µs can be varied by changing the capacitor at pin 7.

### 4.3.1 Trigger Path

The incoming MPX signal is highpass-filtered, amplified and rectified (block RECT-PEAK). The second order highpass-filter has a corner-frequency of 140KHz.

The rectifier signal, RECT, is used to generate by peak-rectification a signal called PEAK, which is available at the PEAK pin 8.

Also noise with a frequency >100KHz increases the PEAK voltage. The value of the PEAK voltage influences the trigger threshold voltage Vth (block ATC). The higher the noise level the higher the threshold.

Both signals, RECT and PEAK+Vth are fed to a comparator (block PEAK-COMP) which outputs a sawtooth-shaped waveform at the TBLANK pin 7. A second comparator (block BLANK-COMP) forms the internal blanking duration of 40µs. The noise blanker is supplied by his own biasing circuit (block BIAS-MONO) to avoid any cross talk to the signal path (block BIAS-MONO).

### 4.3.2 Noise Controlled Threshold Adjustment (ATC)

The behaviour of the noise controlled threshold adjustment is shown in fig. 8. It can be influenced lightly by adding a resistor in parallel to the PEAK capacitor at Pin 8 either to GND or VDD. A resistor to GND will decrease the threshold whereas a resistor to VDD will increase it. But it is recommended to choose one of the internal thresholds by use of the PROG pin (see table 5)

### 4.3.3 Automatic Threshold Control by the Stereoblend voltage (ATC-SB)

Besides the noise controlled threshold adjustment there is an additional possibility for influencing the trigger. It is controlled by the difference between Vsb and Vr, similar to the Stereoblend. The reason for implementing such a second control will be explained in the following: The point where the MPX signal starts to become noisy is fixed by the RF part. Therefore also the starting point of the normal noise controlled trigger adjustment is fixed (fig.9). But in some cases the behaviour of the noiseblanker can be improved by increasing the threshold even in a region of higher fieldstrength, for the MPX signal often shows distortion in this range, which leads to an undesired triggering.

Because of the overlap of this range and the range of the stereo/mono transition it can be controlled by Vsb and Vr. This threshold increase is programmable (see fig. 9).

### 4.3.4 Blend Mode

Another possibility to avoid a disturbing triggering on modulation is to use the spikes on the fieldstrength signal (LEVEL pin). But in the range of higher fieldstrength the signal saturates and no more spike detection is possible. For this reason the TDA7338 offers the "BLEND MODE". When "BLEND MODE" is activated a smooth transition between the LEVEL- and the MPX-signal is used to detect the spikes either on LEVEL or on MPX.

In the lower fieldstrength range mainly the LEVEL-signal is used whereas in the higher range mainly the MPX is used.

This switching is controlled also by the normal Stereoblend signal to avoid additional pins. "BLEND MODE OFF" is activated by connecting the LEVEL pin to GND (LEVEL must be also connected to GND if not used).

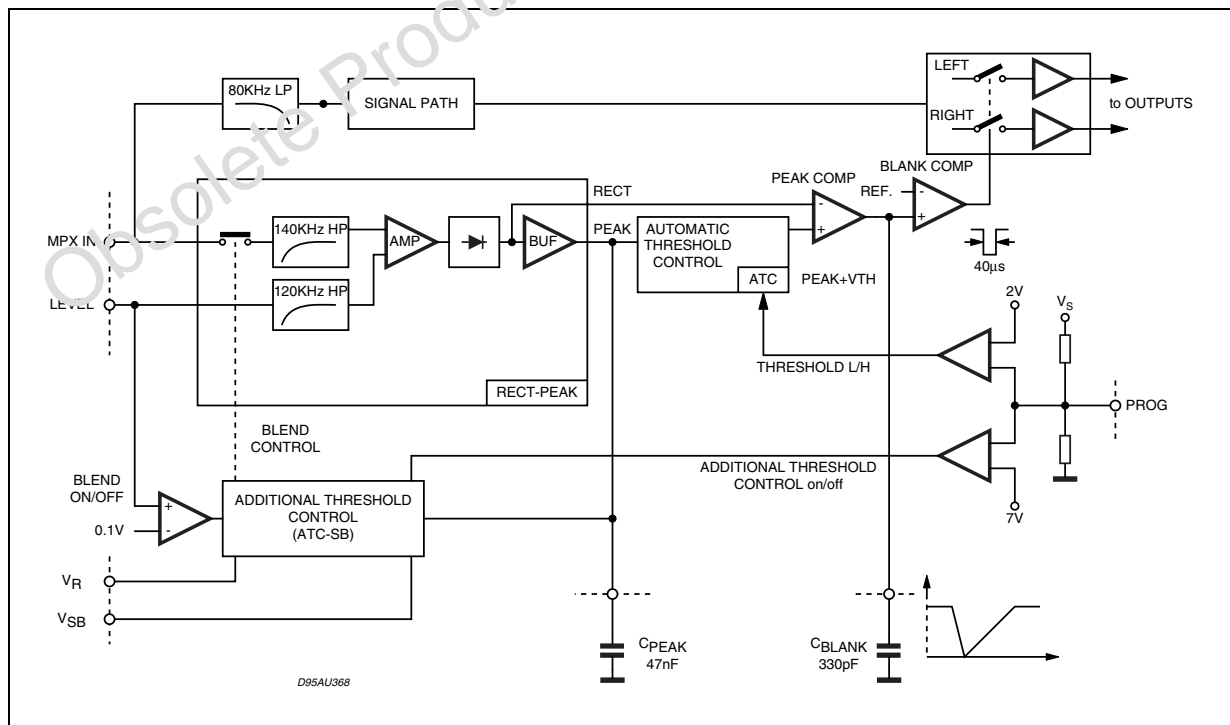### Figure 7. Block Diagram of the Noise Blanker

**Table 5. Programming of the Noiseblanker**

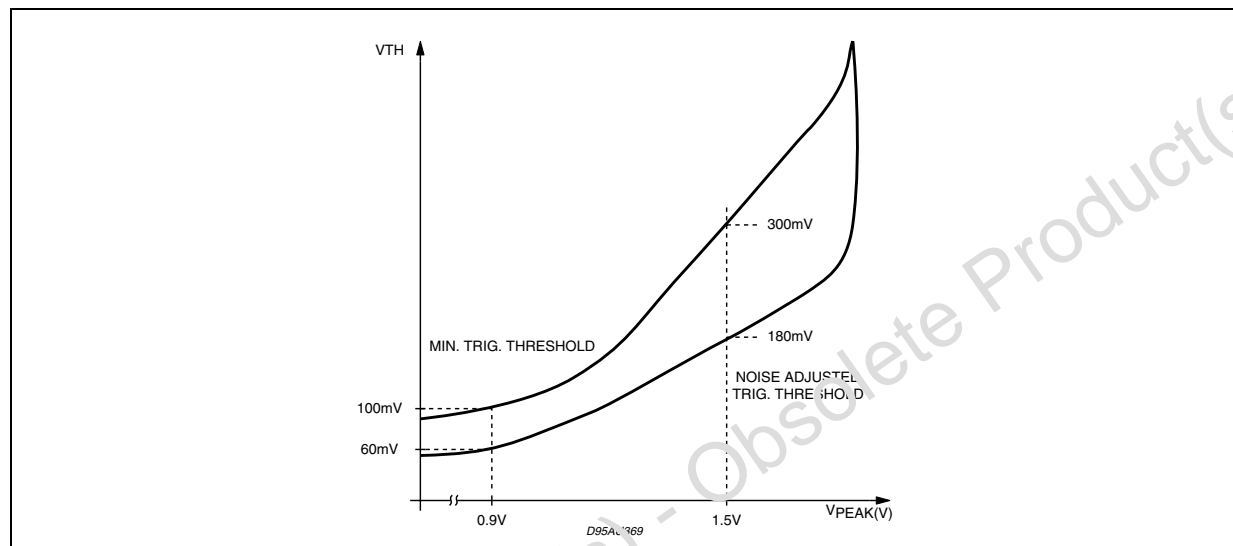| PIN 1 (PROG) | Trigger Threshold | Peak Voltage Control By Fieldstrength |
|---|---|---|
| GND | LOW | ON |
| OPEN | HIGH | ON |
| $V_{DD}$ | HIGH | OFF |

**Figure 8. Trigger Threshold vs. $V_{PEAK}$**



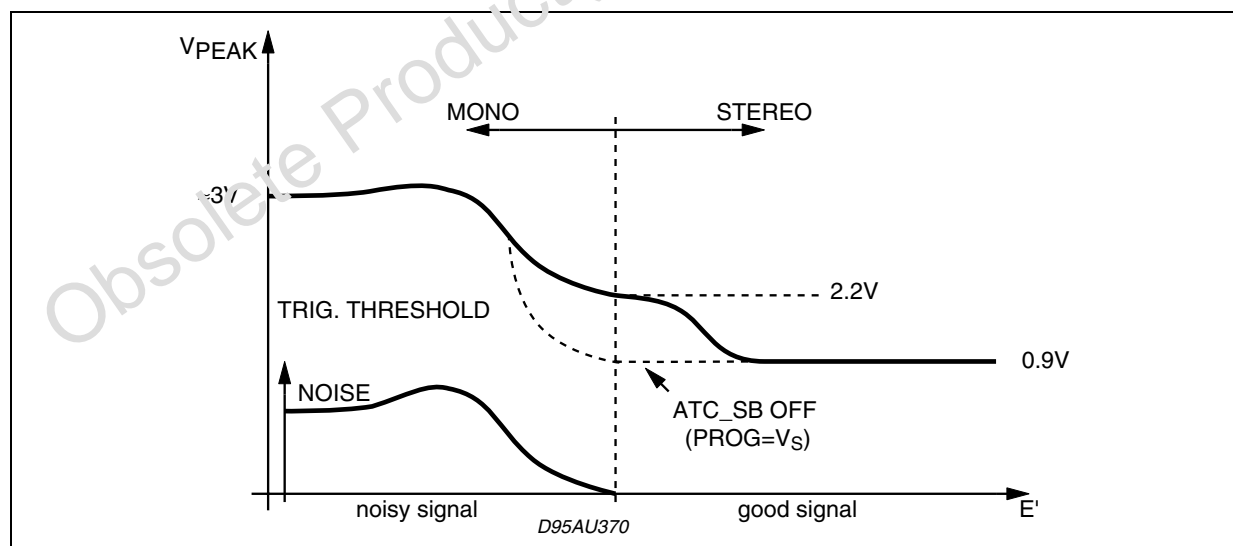**Figure 9. Behaviour of the Field Strength Controlled Threshold Adjustment**
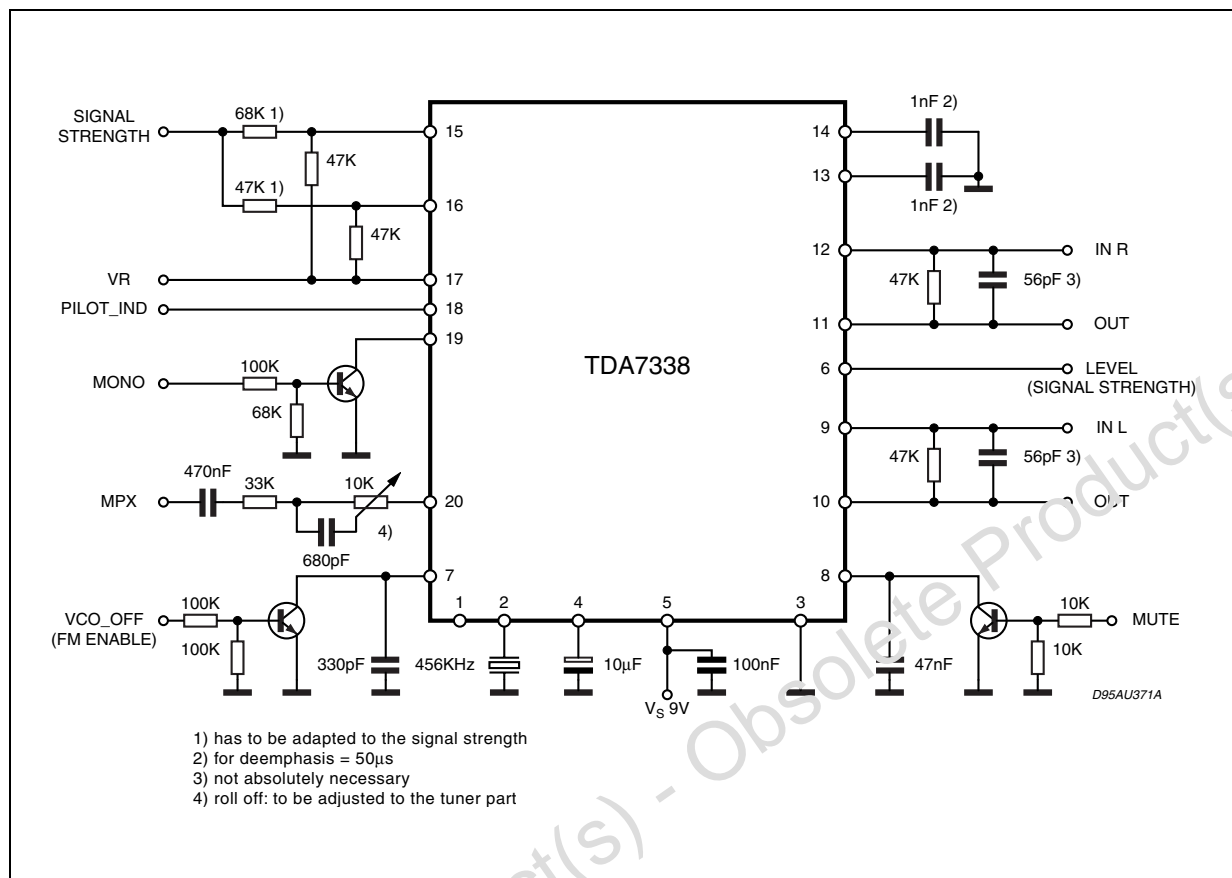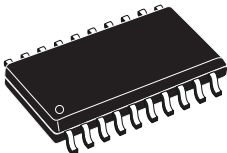
**Figure 10. Application Diagram**



1) has to be adapted to the signal strength
2) for deemphasis = 50μs
3) not absolutely necessary
4) roll off: to be adjusted to the tuner part

**Figure 11. SO20 Mechanical Data & Package Dimensions**

| DIM. | mm | | | inch | | |
|------|-----|-----|-----|-----|-----|-----|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.35 | | 2.65 | 0.093 | | 0.104 |
| A1 | 0.10 | | 0.30 | 0.004 | | 0.012 |
| B | 0.33 | | 0.51 | 0.013 | | 0.200 |
| C | 0.23 | | 0.32 | 0.009 | | 0.013 |
| D [1] | 12.60 | | 13.00 | 0.496 | | 0.512 |
| E | 7.40 | | 7.60 | 0.291 | | 0.299 |
| e | | 1.27 | | | 0.050 | |
| H | 10.0 | | 10.65 | 0.394 | | 0.419 |
| h | 0.25 | | 0.75 | 0.010 | | 0.030 |
| L | 0.40 | | 1.27 | 0.016 | | 0.050 |
| k | 0˚ (min.), 8˚ (max.) | | | | | |
| ddd | | | 0.10 | | | 0.004 |

(1) "D" dimension does not include mold flash, protusions or gate burrs. Mold flash, protusions or gate burrs shall not exceed 0.15mm per side.

**OUTLINE AND MECHANICAL DATA**

**SO20**



0016022 D
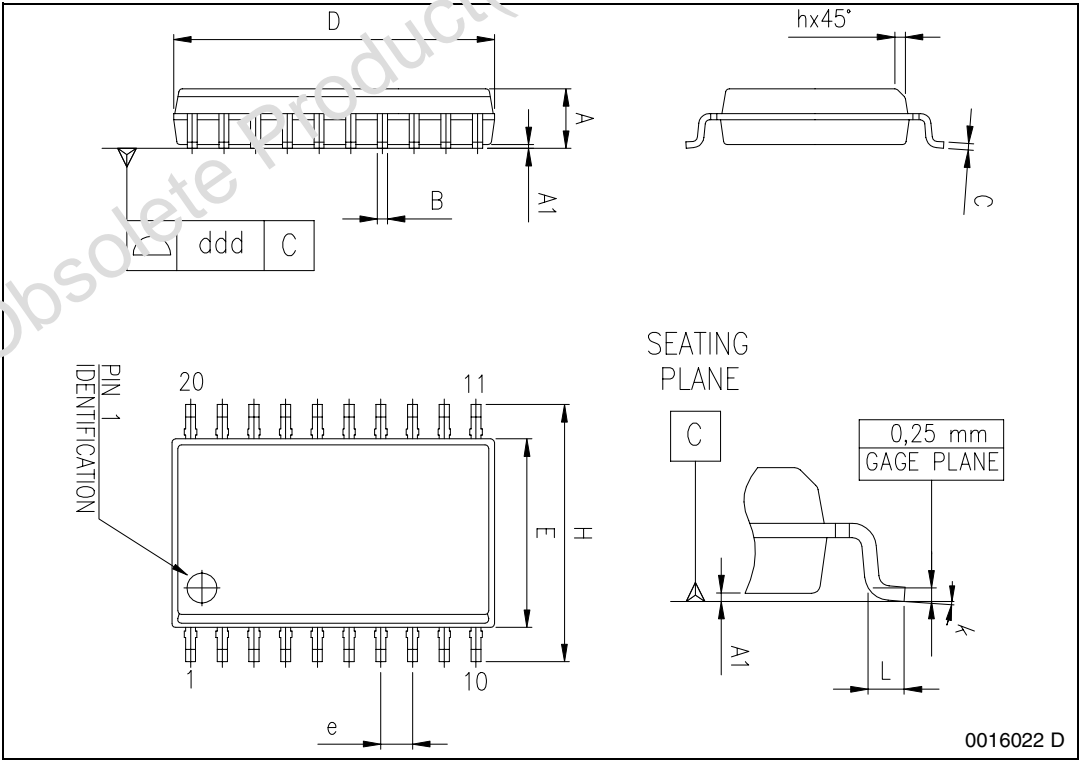
# 5 REVISION HISTORY

**Table 6. Revision History**

| Date | Revision | Description of Changes |
|------|----------|------------------------|
| October 2004 | 8 | First Issue in EDOCS |
| April 2005 | 9 | Changed the Style-cheet in compliance to the new "Corporate Technical Pubblications Design Guide. <br> Deleted DIP20 Package |

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